In Brief

Type 2 diabetes is reaching epidemic proportions: more than 8% of American adults have diabetes now,\(^1\)-\(^5\) and the prevalence of diabetes is expected to double in the next 25 years.\(^6\) What is more alarming is that > 60 million people have pre-diabetes, defined by impaired glucose tolerance (IGT) or fasting glucose, which places them at substantially increased risk for developing diabetes in the near future.\(^1\)-\(^4\),\(^7\) Although intensive treatment of diabetes helps to prevent devastating complications,\(^8\),\(^9\) it does not usually restore normoglycemia or eliminate all of the adverse events associated with the disease. Moreover, the diagnosis of type 2 diabetes is often delayed until evidence of complications is already present.\(^10\) Because current methods of treatment are not optimal, the enormous and growing economic and social costs of diabetes make a compelling case for prevention.

Epidemiological studies have demonstrated that type 2 diabetes results from an interaction between a genetic predisposition and lifestyle factors, including obesity and sedentary behavior. Fortunately, several large clinical trials now provide evidence that type 2 diabetes can be delayed or prevented by changes in these lifestyle factors.\(^11\) Collectively, these studies demonstrate that lifestyle interventions involving structured diet and physical activity programs that result in modest, sustained weight loss in overweight adults with IGT can significantly reduce the development of diabetes.\(^12\)

Recent systematic reviews provide valuable information about the characteristics of successful lifestyle intervention strategies used in past diabetes prevention studies.\(^11\),\(^13\),\(^14\) One key theme evident across studies is the use of cognitive and behavioral strategies to achieve and maintain modest weight reduction (5–7% of baseline body mass) through dietary restriction and moderate daily physical activity. A post-hoc analysis of the Diabetes Prevention Program (DPP) identified that weight reduction was the most consistent predictor of diabetes prevention and that increments in weight loss confer greater levels of diabetes risk reduction. In the DPP, every kilogram (2.2 lb) of weight loss translated to a reduction of ~ 12% in the development of type 2 diabetes.\(^15\)

Weight loss was primarily accomplished by restriction of dietary fat intake to < 25–30% of total calories, with stricter total caloric restriction if initial attempts to achieve weight loss were unsuccessful.\(^11\),\(^13\) Most successful intervention programs also recommended moderate-intensity physical activity (e.g., walking) for 30 minutes daily on five to seven days per week.

Providing Long-Term Support for Lifestyle Changes: A Key to Success in Diabetes Prevention

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Increasing evidence demonstrates that type 2 diabetes can be delayed or prevented in people with elevated risk by modest changes in lifestyle. Research by the Indiana Diabetes Translation Research Center shows that the YMCA organization is a good community partner to implement diabetes prevention programs. YMCA staff trained to deliver a structured lifestyle intervention to prevent diabetes can achieve short-term weight-loss results comparable to those achieved during the Diabetes Prevention Program clinical trial. This research demonstrates that primary prevention is feasible in community settings with a structured program targeting high-risk individuals.
question is, “What are the modifiable factors that help to achieve and maintain modest weight loss in people at risk for the disease?” In the DPP, frequency of dietary self-monitoring during the first 6 months was related to success at achieving (after 6 months) and maintaining (at a mean of 2.8 years) both the physical activity goal of 150 minutes weekly and the weight loss goal of ≥7% of initial body weight.16 Likewise, success at achieving the activity goal was related to success at achieving the weight loss goal. Thus, there appears to be a clustering of behavior changes, with participants who adhere to one aspect of the lifestyle regimen more likely to adhere to other aspects. There also appears to be an interdependency of these behaviors on success in adopting self-monitoring practices that lead to modest weight reduction early in the program. Moreover, getting off to a good start appears crucial for long-term success. Both for weight loss and physical activity, success at achieving the goal at the end of the active intervention was strongly related to the probability of success at study end.16 This evidence supports a behavioral approach of incorporating frequent contact and more aggressive approaches at the start of treatment programs.17

Support for Maintaining Lifestyle Changes to Achieve Diabetes Prevention

The emphasis on behavioral regulation inherent in weight-loss interventions highlights the vital role that self-management must play to reduce diabetes risk over the long term. Past weight-loss intervention trials also show that the vast majority of individuals who try to lose weight by self-initiated programs have initial success that is invariably followed by regaining of weight.17 In this context, success in maintaining modest weight loss is enhanced by ongoing cognitive and behavioral support achieved through interventions that continue at a frequency of at least every month.17 Because ongoing behavioral support appears necessary for weight maintenance to prevent diabetes, it is important to consider the types of strategies that have proved effective in weight loss “relapse prevention.”

In the general weight-loss literature, interventions successful in maintaining long-term behavioral goals have typically involved structured one-on-one or group meetings that allow flexibility to work individually with participants to achieve early successes and employ tailored problem-solving strategies to overcome barriers.17 Initial, more intensive phases of most interventions are typically followed by maintenance visits during an extended period of time. Moreover, ongoing support is typically more successful in maintaining weight loss when there is a focus on plans to improve and sustain changes in both diet and physical activity behaviors.17,18

Motivational interventions and social support are also likely to play a role in behavior maintenance.18,19 Motivation can be delivered by way of monetary incentives or cognitive-behavioral strategies to build self-efficacy, address stimulus control, and practice behavioral processes to overcome barriers and prevent relapse. Past studies of monetary incentives at the individual or group level have proved more effective in initial weight loss than in maintenance.18 However, most of these studies have focused on direct monetary payments, so it is not clear if structuring these incentives differently, such as employer contributions to medical savings accounts or discounts on health plan premiums, might achieve different results.

“Activation” has also come into vogue as a more global construct geared toward personal empowerment using strategies to motivate, develop an internal locus of control, and build self-efficacy perceptions.20,21 In this context, sustaining activation would seem pivotal in maintaining weight loss. Central to such an approach is the teaching of maintenance-specific skills aimed at identifying situations in which relapse is likely to occur, planning strategies in advance to avoid lapses, and getting back on track quickly when they occur.18 Social support interventions have included physical activity partners, group problem-solving and exercise classes, and spousal or peer involvement in behavioral change. Many of these interventions have proved beneficial and typically focus on involving significant others in strategies to support long-term behavior maintenance.18 However, there is less research about the effectiveness of strategies to change an individual’s perception of social norms or the importance of conforming to these norms. Because subjective norms may be modifiable with individually based intervention approaches, more research is required to determine the role of such strategies in diabetes prevention. Finally, although activation, social support, and problem-solving skills have become basic components of most behavioral weight maintenance approaches, there is limited research to guide selection of optimal approaches for implementing these strategies in diabetes prevention.

Preventing Weight Regain in Diabetes Prevention: A Unique Case?

For people at high risk for developing diabetes, it is likely that risk perceptions may also play a particularly important role in achieving and maintaining lifestyle changes.22,23 Conceptually, this may result from an increased perception of threat from the development of diabetes in people who have significant personal experience witnessing diabetes-related complications in family members and peers. In the DPP, 66% of participants reported a family member with diabetes.24 Given the significance of witnessing first-hand the complexity and severity of diabetes and its complications, it is possible that people with pre-diabetes may be more receptive to motivational strategies designed to help them reduce their risk. In this context, the use of ongoing motivational strategies may prove more effective in maintaining weight loss in this unique, “risk aware” population than among people with no personal connection to the lifelong complications of obesity and diabetes.

Similarly, perceptions about the benefits versus hassles of behavioral “treatments” may influence decision balance about adopting or continuing to perform regular self-monitoring of dietary intake and physical activity or about adhering to a diet or physical activity plan. In this context, there may be a role for using reminders or brief, “behavioral refreshment” interventions to avoid relapse during the maintenance phase of modest weight loss. Research in this area, however, is limited and badly needed.

Reminders can occur synchronously with health care visits or asynchronously. Past reviews suggest that brief interventions by health care providers can motivate patients to
consider new lifestyle behaviors, but there is currently insufficient evidence that brief counseling alone can maintain meaningful levels of weight loss by individual patients. Asynchronous reminders can be delivered at either the population or individual level. For example, signs prompting the use of stairs in public settings have had modest effects on changing physical activity behaviors, and public service announcements and other media campaigns have had profound impacts on altering perceptions about tobacco use. Similarly, cell phone text messaging has shown preliminary benefits in decreasing tobacco use relapse. The extent to which these types of strategies may help in preventing weight regain in people at risk for diabetes remains to be seen.

Finally, adults with pre-diabetes who perceive that their personal risk for developing diabetes is significantly increased report that they would be willing to pay as much as $89 per month for 3 years to access a formal diabetes prevention program—an amount that should meet or exceed any residual fees required to support such a program in the community. Because lifestyle interventions to achieve modest weight loss can be costly, more research is needed about the relationships between diabetes risk perceptions and willingness to pay the fees for formal programs that are supportive of weight loss maintenance.

Ongoing Support: The Promise of Community-Based Programs

Formal lifestyle interventions designed to provide support for modest weight loss and physical activity in people at high risk for developing diabetes are likely to have favorable cost-effectiveness. Indeed, community-wide initiatives to implement and sustain such interventions could have the strongest impact on the prevention of diabetes on a population scale and are likely to represent a wise use of resources to improve health.

Focused diabetes prevention programs supported by the community should be particularly attractive to health care payers and purchasers because they offer the potential for resource-sharing arrangements that could improve program sustainability. One recent prediction model demonstrated that financing of a DPP lifestyle intervention could offer a favorable business incentive for a health payer that covers up to half of the direct program costs, even if implementing such an intervention achieves only half of the effectiveness observed in the DPP clinical trial. Because the DPP also found that lifestyle intervention participants had fewer work absences, employers may have an added incentive for helping to support these initiatives.

Although research suggests that coverage for formal diabetes prevention programs is likely to have a strong business incentive for employers and health payers, one remaining source of uncertainty for these stakeholders is whether community organizations offering such a program can deliver a high-quality program that helps community members with pre-diabetes achieve and sustain modest weight loss. There is very little published literature in this area, but the results of ongoing studies should help to inform policies in the near future.

Preventing Diabetes in the Community: The YMCA Model

Since 2003, the Indiana University Diabetes Translational Research Center has collaborated with the YMCA of Greater Indianapolis to develop, demonstrate, and evaluate novel strategies to transfer the DPP lifestyle intervention into the public health sector. This collaboration has included a community-based, randomized pilot trial to evaluate the feasibility and effectiveness of delivering a group-based adaptation of the DPP lifestyle intervention in YMCA facilities. As was the case with the DPP, the curriculum emphasized developing the necessary self-management skills to successfully lose 5–7% of initial body weight and increase physical activity to a minimum of 150 minutes per week. The decision to place the intervention in community YMCA sites reflects a belief that behavioral-based programs will be used more if they are located in proximity to where at-risk people live, work, and play, thereby reducing barriers associated with programs implemented in centralized settings that require additional commitments of time and personal resources.

This pilot randomized trial recruited adult community residents by conducting diabetes risk screening and counseling at two Indiana-
onstrates that primary prevention is feasible in community settings with a structured program targeting high-risk individuals and that ongoing support may help to maintain modest weight loss after 1 year.

Because prior analyses of DPP data have suggested that this level of weight loss would translate to at least a 50% reduction in new cases of type 2 diabetes,13 more research is needed to determine the feasibility and effectiveness of working with the YMCA and other community partners to deliver formal lifestyle diabetes prevention programs on a broader scale. Moreover, because it appears that broader environmental and policy interventions targeting healthy diet and physical activity may offer additional, incremental support for behavior change,2,24 it will also be important to investigate whether formal community-based diabetes prevention programs are more successful and sustainable when offered in the context of context-wide initiatives that provide a backdrop of supportive resources to adopt new behaviors, achieve weight loss, and prevent relapse.

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References
3Centers for Disease Control and Prevention: Diabetes: Disabling, Deadly, and on the Rise. Atlanta, Ga., Centers for Disease Control and Prevention, Department of Health and Human Services, 2004
7Centers for Disease Control and Prevention: National Diabetes Fact Sheet: General Information and National Estimates on Diabetes in the United States, 2003. Atlanta, Ga., Centers for Disease Control and Prevention, Department of Health and Human Services, 2004


39 National Diabetes Education Program: Diabetes Prevention. Bethesda, Md., National Institutes of Health, the Centers for Disease Control and Prevention, Department of Health and Human Services, 2004


42 Centers for Disease Control and Prevention: *Obesity: Guide to Community Preventive Services*. Atlanta, Ga., Centers for Disease Control and Prevention, 2006

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